



# Concrete Made With Waste Materials - A Review

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## Abstract

*The rapid population increase, industrial activities and living trends are generating variety of waste materials. These on the one hand require costly disposal practices and invaluable land while on the other hand pollute the different natural resources and environment. Further, a lot of natural resources are being depleted at a much faster rate now than ever before. The use of waste or waste by product for substitutions of cement and aggregate has greatly contributed to sustainable development practices. The replacement of cement and aggregates by waste materials either in part or in whole improves the mechanical properties too viz., compressive strength, flexural strength, tensile strength, bond strength, modulus of elasticity and reduces permeability, chloride penetration and chloride diffusion of concrete. The workability of waste concrete is generally improved. In this paper, a review of the effects of waste inclusion on the properties of fresh and hardened concrete is presented.*

**Keywords:** Waste materials; Flexural strength; Modulus of elasticity; Permeability

## 1. INTRODUCTION

There are several types of wastes being generated from various industries and modern trends of living. Some of these wastes are harmful, if properly unattended to and require costly treatment and disposal to avoid harming the environment besides being costly, these require large amount of land which may otherwise be used for beneficial purposes. With the growth of population, the quantum of wastes being generated is increasing continuously. One of the methods to properly utilize and consume these wastes lies in the construction industry practices, wherein these wastes may be used and stabilized, so as to prevent further pollution of our natural sources.

The construction sector's major contribution towards the preservation of

environment and sustainable development lies in the reuse and recycling of the waste materials. Industrial activities generate a huge amount of different types of wastes that are recycled or stored in disposal land fill sites which could affect seriously the environment. Owing to the increasing demand for construction projects which in turn increases the amount of raw material used, the incorporation of subproducts in concrete industry has become a common practice in the last few decades. Of late the inclusion of different types of by products in cement based materials has become a common practice (Bouzoubâa et al. 2003, Li et al. 2002, Concrete London 2003, Naik et al. 2003, Naik et al. 2004). Most of the investigations have mainly focused on the use of sub-products as supplementary materials, admixtures or recycled aggregates in concrete. It is expected that various other types of solid and industrial waste by-products can also be used in concrete making. Different types of wastes viz. municipal waste, agricultural waste, demolition waste etc. create serious disposal problems in terms

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that WPLA concrete at 25% replacement level had no significant difference as compared to CC but on further increase in replacement level, the compressive strength decreased. Suzuki et al (2009) reported that the compressive strength of porous coarse aggregate concrete at 28 days was higher by 20% as compared to the CC. Fonteboia and Abellal (2008) reported that compressive strength of RC is almost similar to that of CC at 28 days. Nehdi and Sumner (2003) reported that the concrete made using waste latex paint (WLP) has compressive strength almost similar to that of CC at 28 days. Pacewska et al. (2009) reported that utilization of zeolitic waste material obtained through fluidized bed cracking catalyst (FBCC), as replacement of cement upto 20% increased the compressive strength by 40-60% at 28 days. Adesanya and Raheem (2009) reported that CCA blended concrete showed improved compressive strength at later ages. Oner et al (2009) reported that 40% replacement of cement by fly ash marginally increased the compressive strength.

### **Tensile Strength**

Jabri et al (2000) reported increase in tensile strength (13 -15 %) upto 50% copper slag content. Santharamai and Manoharan (2004) reported that the tensile strength of ceramic waste concrete is 18% below than CC. Suzuki et al reported a slight decrease in tensile strength of porous ceramic coarse aggregate(PCCA) concrete. Fontehoa and Abellal (2008) reported that the tensile strength of RC at 7 and 115 days are slightly more (1.5 and 1.42% respectively) than CC, however, at 28 days it is slightly lower. Choi et al(2005) reported that the tensile strength of WPLA concrete is 8.7-10% of its compressive strength, which is within the range of 7-11% in the case of CC.

### **Flexural Strength**

Jabri et al (2000) reported a marginal decrease in the flexural strength of copper slag concrete. Santharamai and Manoharan (2004) reported that the flexural strength of concrete made

using ceramic waste is about 6% lower than CC. Nehdi and Sumner (2003) reported that the concrete with WLP showed increased flexural strength in the range of 7-17%. Topcu and Sengal (2004) reported a decrease (13%) in the flexural strength of concrete when normal aggregates were fully replaced by WCA.

### **Bond Strength**

Sarswathy and Song (2007) reported that incorporation of rice husk ash (RHA) upto 30% replacement level increases the bond strength by 4 -23 %.

### **Modulus of Elasticity**

Santharamai and Manoharan (2004) reported that the modulus of elasticity of ceramic waste concrete is slightly less than CC. Choi et al (2005) reported that the ratio of modulus of elasticity and compressive strength ( $E_c/f_c$ ) of WPLA concrete is in the range of  $6.27-7.46 \times 10^2$ . Suzuki et al (2009) reported a marginal decrease in Young's modulus of high performance concrete (HPC) mix containing PCCA at 28 days in comparison to the controlled mix. Fontehoa and Abellal (2008) reported that the static modulus of elasticity of RC is lower (7.5-11.3%) than CC.

### **Durability**

AchtemIchuk et al reported that the use of controlled low strength material along with fine recycled aggregate showed excellent resistance to degradation at 20 and 30% slag content in concrete without OPC. Chalee et al (2009) reported that replacement of cement by fly ash upto 50% reduced the chloride penetration and steel corrosion in concrete. Nehdi and Sumner (2003) reported that WLP decreased the rapid chloride penetrability by about 55%.

Thus, it is seen that the concern for environmental pollution, environmental protection, optimum use of natural resources and reuse of

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